Sun-Spots and Terrestrial Magnetic Storms

My attention has been called to a remark in my recent lecture on "Cipher Messages from the Stars" which seems to state too positively that terrestrial magnetic disturbances have their origin in the magnetic fields of sun-spots. It has been known for a long time that a close relationship exists between sun-spot activities and terrestrial magnetic storms. Therefore Hale's discovery of strong magnetic fields in sun-spots naturally suggested that these fields were the sources of the terrestrial magnetic disturbances. However, the determinations of the field strengths, in numerous spots, from the separation of the spectral lines as Zeeman effects showed that the magnetic forces involved were too small to produce at the Earth's distance direct magnetic effects of the order of those observed. The well-known hypothesis that the aurorae are produced by streams of electrically charged particles expelled from the Sun and entrapped by the Earth's magnetic field, seems to offer an explanation of the terrestrial magnetic disturbances, which always accompany auroral displays, as the magnetic effects of moving charges. According to this hypothesis the charged particles would be expelled in greater numbers at the time of great solar activity and hence we should expect a close relationship between the occurrence of sun-spots and terrestrial storms. That these charged particles are present in the Sun is inferred from the existence of magnetic fields in the great solar vortices known as spots.

This point of view has met with some criticism from certain physicists, who have suggested that terrestrial magnetic storms have their origin in electric currents in the upper atmosphere, induced by the sun-spot fields.

While the evidence has generally been regarded as favoring the charged-particle hypothesis, it would appear that the actual manner in which magnetic disturbances on the Earth are produced is not thoroly understood.

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The Angular Diameter of α Bootis by the Interferometer

Since the measurement of the diameter of *Betelgeuse* in December, 1920, observations for the determination of stellar diameters have been continued with the 20-foot interferometer attached to the upper end of the 100-inch Hooker reflector.

Several definite results have been obtained, and others less definite because of poor observing conditions, have been partially checked by comparison with stars whose diameters are known to be too small for measurement with this instrument. Let the visibility of the zero fringes for any particular separation of the mirrors be reduced by bad seeing as compared with that on a fine night; it is then hopeless to make final measures. If, however, the interferometer is turned to a neighboring check star and the fringes are seen, and then turned to the star under consideration and they do not appear, the observer is justified in saying that there is a definite decrease in visibility.

The data thus far obtained are as follows: For *α Tauri* (*Aldeberan*) fringes of gradually decreasing visibility have been observed at 13, 14.5, and 19 feet. Further observations are necessary between the last two positions to determine whether the fringes vanish between these points or whether a longer beam will be necessary to obtain a measure of the diameter. If the fringes vanish around 16-18 feet, as observations under poor conditions lead one to suspect they will, then the fringes observed at 19 feet must lie beyond the point of disappearance, on the ascending branch of the visibility curve where it is rising toward the second maximum.

For *β Geminorum* (*Pollux*) fringes have been observed at separations of 14.5, 16, and 19 feet, the visibility being definitely reduced for these distances of the mirrors; but at 19 feet it is still considerable. A longer beam will therefore be required for the measurement of this star's diameter.

For *α Ceti* one observation at 13 feet with variable seeing showed a reduction in visibility of the fringes when compared with that of the check star.

For *α Bootis* (*Arcturus*), observations in February and March, with poor seeing, indicated a decided reduction in the visibility of the fringes with increasing separation of the mirrors. On April 15th a series of measures was made under conditions which were excellent as indicated by the strong contrast of the zero fringes and by diffraction rings surrounding the central disk of the star images.

At 16 feet separation of the mirrors the visibility of the fringes was estimated at 20 to 25 per cent of the zero fringes; at 17.5 feet, 15-20 per cent, certainly less conspicuous than at 16 feet. At 19.0 feet the estimate was 5 per cent, the contrast being very flat, but the fringes were picked up with certainty as the path difference

was varied with the optical wedge. At 18.25 feet, the result was 15 per cent, certainly greater than at 19.0 feet; and finally, at 19.5 feet, no fringes whatever could be observed from the interferometer mirrors. There was no bright star in the immediate neighborhood that could be used as a check, but the instrument was known to be in adjustment for the final measure from the certainty with which the previous settings had been made.

The separation of the mirrors for disappearance of the fringes may therefore be placed at 19.5 ± 0.5 feet, altho observations with a longer beam with which the second maximum could be observed, might possibly increase this value a trifle. By disregarding any possible darkening at the limb, the result will serve to indicate the maximum diameter of the star. The spectrum of *α Bootis* is Ko; its approximate effective wave-length may therefore be taken at 5.6×10^{-5} cm, about half way between that of the Sun (Go) and that assumed for *α Orionis* (Ma).

With this value of λ and a distance of 19.5 feet (594cm), the angular diameter of *α Bootis* is $0''.0237$. It is interesting to note the close agreement of this figure with the estimated values of Eddington ($0''.020$) and Russell ($0''.019$), and with Hertzsprung's value ($0''.026$) calculated on the basis of the measured diameter of *α Orionis* ($0''.045$).

Results for the parallax of *α Bootis* are as follows: Yale, $0''.074$; Flint, $0''.095$; Yerkes, $0''.100$; Adams, spectroscopic, $0''.158$; the weighted mean is $0''.116$. The distance of *Arcturus* is therefore of the order of 1.65×10^{14} miles (2.65×10^{14} km), and its linear diameter 19×10^6 miles (30.6×10^6 km), or about 22 times the diameter of the Sun.

All settings of the mirrors have thus far been made by hand, and considerable time is consumed between measures. Two screws are now being mounted on the beam, driven by a single motor, which for any separation will keep the outer mirrors equidistant from the fixed inner mirrors and thus greatly facilitate the operation of the interferometer.

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NOTE ON THE SPECTROSCOPIC BINARY, p VELORUM

In a list of radial velocities secured at the Royal Observatory, Cape of Good Hope, and published by Dr. Joseph Lunt[1], six values

[1] *Ap. Jour.* 50, 161, 1919.